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DREDGED MATERIAL RESEARCH

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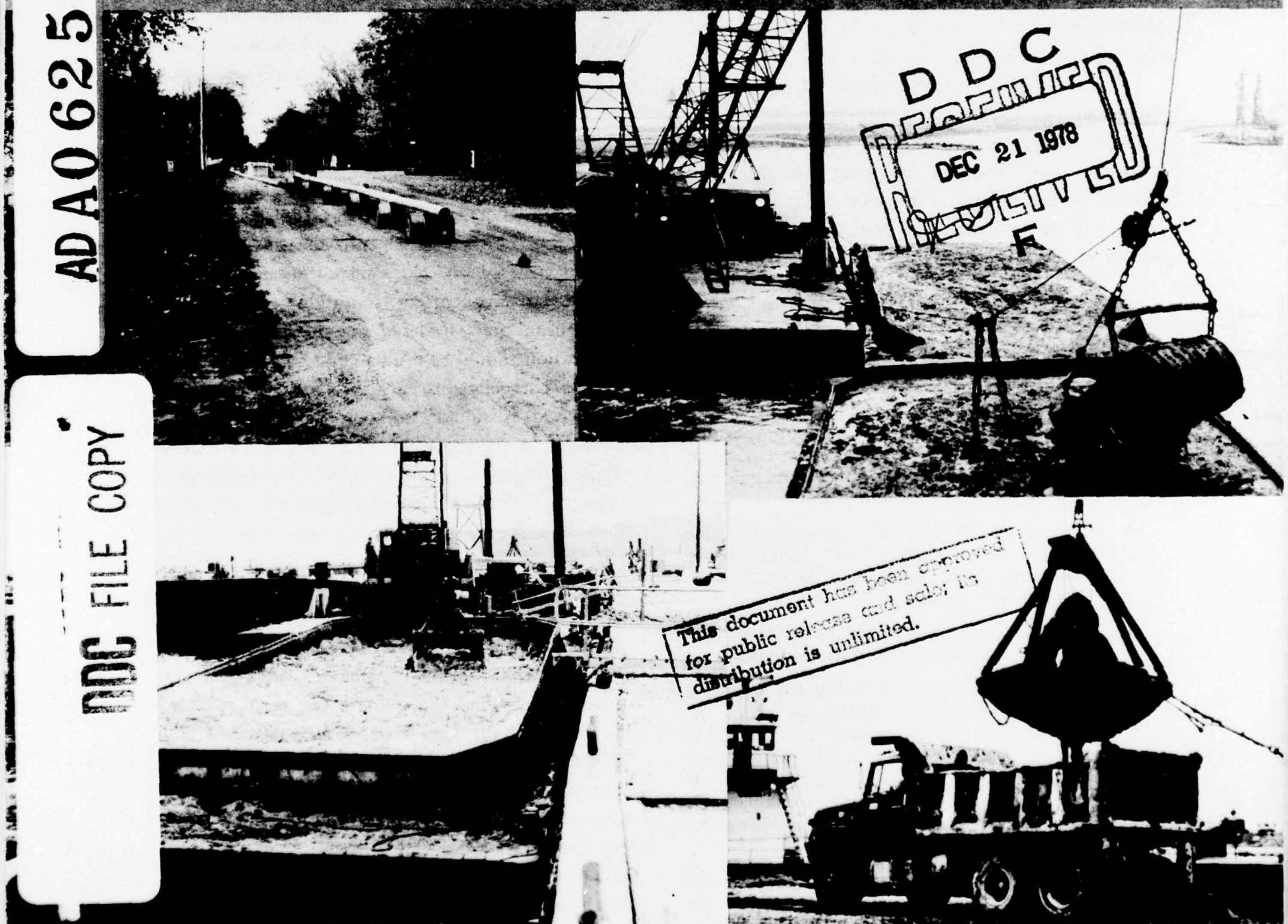
NOTES • NEWS • REVIEWS etc



Inland transportation of dredged material may be necessary as a disposal alternative or for the productive use of the material. Work Unit 3B01 of the Dredged Material Research Program (DMRP) was conducted to identify and evaluate transportation systems such as pipeline slurry, rail haul, barge movement, truck haul, and belt conveyor. Pipeline, barge, and truck modes are shown above. Results of the investigation are given in the following article.

TRANSPORT SYSTEMS FOR INLAND DISPOSAL AND/OR PRODUCTIVE USE OF DREDGED MATERIAL

As part of the Productive Uses Project of the DMRP, Task 3B was designed to explore upland disposal concepts. Under Work Unit 3B01, the General Research Corporation, McLean, Virginia, identified and evaluated transport systems applicable to the inland movement of dredged material for disposal and/or productive use. Mr. Paul J. Souder, Jr., Project Director, was assisted by Mr. Leo Tobias and Ms. Frances C. Mushal. Technical consultants were Mr. Louis Mauriello and Dr. John B. Herbich. The following article is taken largely from the report of the study (Technical Report D-78-28).

Five basic transportation modes were examined: pipeline slurry, rail haul, barge movement, truck haul, and belt conveyor movement. Two pumping methods, centrifugal and Pneuma pumping systems, were analyzed for pipeline slurry transportation. No attempt was made to evaluate the viability of potential productive uses or the suitability of inland disposal.

APPROACH

The following activities were performed for the study:

- An in-depth literature review of prior studies involving technical and economic aspects of alternative transportation modes (pipeline, rail, truck, barge, and belt conveyor).
- Research on the technical aspects of hydraulic pipeline transportation, rail haul, barge movement, truck haul, and belt conveyor transportation modes.
- Detailed design data and parameters for the hydraulic pipeline transportation alternative.
- Detailed total and unit cost estimates (including material handling costs as well as transportation costs) for each transportation alternative based upon varying annual quantity movements over varying distances. Annual quantities ranged from 500,000 to 5,000,000 cu yd per year for each application, and distances were varied from 6 to 300 miles.
- Sensitivity analyses to determine effect on total costs of varying the values of several of the principal design parameters and cost elements.
- A comparative analysis of transportation alternatives based upon technical and economic considerations.
- Legal, institutional, environmental, and other potential constraining considerations to be examined prior to the implementation of a desired transportation alternative.

FINDINGS

The report is intended to provide generalized data that can be utilized in evaluating the economic potential of inland disposal alternatives for specific applications across the country. In this regard, considerable detail from both a technical and economic point of view was provided to allow the user to apply the information to a particular situation. Where a given application requires modification in a specific transportation concept and/or an alteration in specific cost elements, the level of detail in the report should facilitate any such required changes.

General

The findings were based on the assumptions made and discussed in the report on this study. These findings should be regarded as generalized evaluations of the related costs of selected transportation modes under representative operating conditions. When specific applications are considered, the unique aspects of each application should be evaluated individually and more precise costs related to each specific application should be derived. It should also be noted that cost estimates provided in the report are expressed in 1976 dollars. These estimates can be converted to current dollars by adjusting for price changes that occur between 1976 and the time a specific application is considered.

Overall, it was observed that, irrespective of the annual volume of movements, belt conveyor and truck haul systems are considerably more expensive than pipeline, rail, or barge transportation systems. At the 500,000-cu-yd annual volume movement level, hydraulic pipeline transport is the most economical mode for distances up to about 20 miles. Beyond this distance and up to the limiting distance of this study, movement by barge is the most economical transport system. Movement by hydraulic pipeline is more economical than movement by rail up to a distance of about 60 miles. Beyond this point rail movement becomes less costly than pipeline movement. Therefore, for those applications where barge haul is not feasible (lack of suitable waterway to support barge to transport), the trade-off point between hydraulic

pipeline transport and rail transport is at the 60-mile distance.

When this annual volume movement level is increased to 1,000,000 cu yd, the distance to which hydraulic pipeline transport is the most economical increases from 20 to 50 miles. Barge haul is still the most economical beyond that point; however, where barge haul is not feasible, the trade-off point between rail and hydraulic transport is at the 75-mile distance.

At the 3,000,000-cu-yd annual movement level, hydraulic pipeline transport is the most economical up to a distance of about 115 miles. Up to and beyond this point, rail movement is now more economical than barge haul. As the annual volume movement increases above this level, there are no significant changes in the above cost pattern except that hydraulic pipeline transport is the most economical up to its 125-mile practicl limitation.

Hydraulic Pipeline Transport

For annual volume movements of 500,000 cu yd, total hydraulic pipeline transport costs will vary from about $2.75 per cu yd at 20 miles to about $10 at 120 miles. For annual volume movements of 5,000,000 cu yd, total hydraulic pipeline transport costs will vary from about $0.80 per cu yd at 20 miles to about $3.60 at 120 miles. From these data it is apparent that for hydraulic transport of dredged material, unit costs (dollars per cubic yard) will drop significantly for the larger volume movements. It is also observed that for distances under about 50 miles, hydraulic transportation of dredged material inland is the economic choice among transportation modes in all instances for volume movements in excess of 1,000,000 cu yd per year.

The total costs associated with centrifugal and Pneuma pumping systems are closely comparable. In some instances centrifugal pumping is more economical and in other instances Pneuma pumping will be the more economical. However, the trade-off between the two pumping systems is so close that each one should be evaluated separately based upon the unique requirements of the case.

Rail Haul

For annual volume movement of 500,000 cu yd, total rail haul rates will vary from about $5.80 per cu yd at 50 miles to about $8.90 at 300 miles. For annual volume movements of 5,000,000 cu yd, total rail haul rates will vary from about $3.00 per cu yd at 50 miles to about $6.10 at 300 miles. The large reduction in total rail haul costs associated with larger volume movements can be attributed to reduced material handling unit costs (loading and unloading) and reduced transportation unit rates.

The break-even point between rail and barge haul for transporting dredged material inland occurs at annual volume levels of about 2,000,000 cu yd. At higher annual volume levels, rail haul will be more economical; at lower annual volume levels, barge haul appears more economical (all other factors considered equal). In every case between 50 and 300 miles, rail haul appears to be more economical than either truck haul or belt conveyor movement.

Barge Haul

For annual volume movements of 500,000 cu yd, total barge haul rates are estimated to be about $3.40 per cu yd at 50 miles and about $7.40 at 300 miles. For annual volume movements of 5,000,000 cu yd, total barge haul rates are estimated to be about $3.15 per cu yd at 50 miles and about $7.20 at 300 miles. Since barging costs (both material handling and transportation elements) are considered to be closely related to volumes transported, only marginal cost reductions are observed in transporting larger annual volumes of material.

Overall, the results of the analysis indicate that for the lower annual volume movements, barge haul is one of the most economic means to transport dredged material inland. At the 500,000-cu-yd level, barging becomes the most economical option for distances in excess of 20 miles. At the 1,000,000-cu-yd level, the pipeline versus barging break-even point occurs at about the 50-mile point.

Truck Haul

For annual volume movements of 500,000 cu yd, total truck haul costs will vary from about $7.75 per cu yd at 30 miles to about $13.40 at 120 miles. For annual volume movements of 5,000,000 cu yd, total truck haul costs will vary from about $6.20 per cu yd at 30 miles to about $12.00 at 120 miles. Large-scale truck haul movements will yield reduction in unit costs; however, in comparison with other transportation alternatives, truck haul of dredged material is not closely competitive. In every case, where direct comparisons are valid, pipeline slurry, rail, and barge haul are more

economical than the truck haul option. The underlying reasons for these results can be many, but the most notable is that for the large annual volumes under consideration in this study, truck haul is a labor- and fuel-intensive mode of transportation in comparison with other transportation modes.

Belt Conveyor Movement

At the lower annual volumes, belt conveyor unit costs are dramatically higher than any of the other competing transportation modes. However, at the higher annual cubic yard volume levels and over small distances (less than 20 miles), belt conveyor movement becomes competitive with all transportation alternatives except the pipeline slurry option. This result depicts the economic nature of belt conveyor transportation, which is its high investment cost but inherent ability to move extremely large annual quantities of bulk materials.

RECOMMENDATIONS

Based upon the technical considerations and cost derivation assumptions followed in the study, pipeline slurry transportation is the most economical choice in most instances for distances up to about 100 miles but only where annual quantities exceed 1,000,000 cu yd. For longer distance movements, barge or rail haul will be the most economical selection depending on annual volumes to be transported. Generally, rail becomes the more economical choice at the higher volumes.

Cost Data Comparisons

Care must be taken in comparing cost data between transportation modes because each mode requires a specific transport route (rail line, waterway, etc.), which in the majority of instances will result in varying distance movements associated with each transportaiton mode for a given application. It should also be noted that, in some cases, combinations of transportation modes may be required to transport dredged material to an inland site. It is possible for a specific application that barge and truck haul, or barge and pipeline slurry modes, as well as other potential combinations, could be utilized. For economic evaluation of these cases, unit costs can be easily combined to evaluate the total transportation system's cost. However, care must be exercised to avoid double counting of the material handling activity at the point where the two transportation modes interface.

Distance Limits

Unless unusual circumstances exist for a given application, the following practical distance limits are recommended for each transportaiton mode.

Hydraulic Pipeline Transport. It is recommended that the pipeline alternative be considered for distances up to about 125 miles. Distances in excess of 125 miles will increase the potential for system breakdown because of the increasing number of booster stations required.

Rail Haul. Rail haul should be considered for distance movements between 50 and 300 miles. Cost data are only fragmentary for distances of less than below 50 miles.

Barge Haul. Barge haul can be considered for all applications where suitable waterways exist.

Truck Haul. Truck haul should only be considered for distances less than 50 miles. Movement of large quantities of dredged material in excess of 50 miles will be very uneconomical.

Belt Conveyor. Belt conveyor movement is best considered for those applications where very large volumes are required to be moved short distances. Practical distance limits for belt conveyor applications will be under 50 miles.

Selection Procedure

In selecting the most desirable transportation alternative, it is recommended the following sequence be followed.

- Identify the available transportation routes and their respective distances for the movement of dredged material inland. In many cases a transportation alternative may be eliminated for lack of a suitable transportation route.
- Identify the nature and characteristics of the material to be transported (i.e., wet or relatively dry state, in situ density).
- Determine the annual volume of material to be transported and the anticipated duration (years) of the project.
- Derive estimated yearly costs for each transportation alternative based upon the methodology presented in this report. If cost data that are presented in the report are utilized, care should be taken to update these data as required for the application under consideration.
- Evaluate additional technical, legal, environmental, and institutional considerations for

each mode to ensure the practicality of the application.

- Select the desired transportation alternative.

The above generalized procedure coupled with the detailed design and cost derivation methodology contained in this report will serve as a guide in evaluating among transportation systems for the movement of dredged material inland.

DOTS MANAGEMENT TEAM ANNOUNCED

Mr. Charles C. Calhoun, Jr., has been named Program Manager for the Dredging Operations Technical Support (DOTS) activities of the WES Environmental Laboratory. Mr. Calhoun will be assisted by Mr. Thomas R. Patin and Dr. Thomas D. Wright. They will be responsible for providing assistance in response to requests from Districts, Divisions, and the Office, Chief of Engineers, on the application of DMRP results to specific problems. Three other dredging-related activities are also under the DOTS management umbrella. The first is the continued monitoring of longer term trends at two of the four DMRP open-water disposal field test sites and seven habitat development field sites. Another is the continuing effort to develop the guidelines and criteria required for the Corps' environmental-related permit programs. The third is field testing and refinement of procedures developed to size containment areas and densify dredged material within containment areas.

Calhoun, a Research Civil Engineer, was Manager of the DMRP Disposal Operations Project. In this capacity he was responsible for most of the engineering or operational aspects of the DMRP.

Patin, also a Research Civil Engineer, was Manager of the Productive Uses Project for the last two years of the DMRP. Prior to that assignment he was on the staff of the Habitat Development Project.

Wright, a Biological Oceanographer, was closely associated with research conducted by the DMRP Environmental Impact and Criteria Development Project on the effects of the open-water disposal. Dr. Wright has also performed extensive research and evaluations of environmental impacts of dredging and disposal operations for various Corps Districts.

The team represents knowledge in all aspects of the completed DMRP. In response to specific requests from the field, the team will also draw heavily upon the experience and expertise of other individuals to provide the required assistance.

Any Corps operating element can request assistance on any matter related to applying DMRP results. Inquiries or requests for assistance should be made to Mr. Calhoun (AC 601, 636-3111, ext. 3428 or FTS 542-3428), Mr. Patin (ext. 3444, FTS 543-3444), or Dr. Wright (ext. 3708, FTS 542-3708).

U. S./EUROPEAN DREDGING IMPACT SYMPOSIUM

The Second U. S./European Symposium on the Environmental Impact of Dredging and Dredged Material Disposal was recently held at WES. There were 31 invited participants from the U. S., the Netherlands, England, F. R. Germany, Wales, and France. Some of the participants at the Symposium are shown in Figure 1. A list of attendees is shown in Table 1. The purpose of the Symposium was to update the coordination of research activities and the awareness of results of research being conducted in the U. S. and Europe begun at the first symposium held in Rotterdam in 1977.

The Symposium, cochaired by Mr. Kees d'Angremond, Adriaan Volker Dredging Company, Rotterdam, and Mr. Charles C. Calhoun, Jr., WES, consisted of three days of presentations and discussions of research and research results applications. On the fourth day, the Vicksburg District of the Corps hosted the participants on the dustpan dredge JADWIN. Some photos of the field day activities are shown in Figure 2.

No formal papers were prepared for the Symposium, thus no proceedings will be published. The general topics covered by the participants are given in Table 2. Anyone interested in obtaining any additional information on the specific topics should contact the participant or Mr. Calhoun.

The Symposium substantiated that possible environmental problems associated with dredging and disposal are not unique to the U. S. Extensive research is carried out in Europe to determine the environmental effects of dredging and disposal and to provide methods of minimizing any adverse impacts. Because of the success of the first two symposia, it is hoped that future symposia will be held on a regular basis to ensure continued awareness and coordination of effort .

Figure 1. Some of the participants at the Symposium are shown above. Row 1 (l-r): T. R. Patin, U. S.; Dr. J. Wiersma, The Netherlands; I. B. Kyzer, U. S.; Dr. U. Forstner, Federal Republic of Germany; L. Nederlof, The Netherlands. Row 2: R. W. Holland, England; Dr. R. H. Jones, Dr. R. H. Plumb, Dr. T. A. Haliburton, R. L. Montgomery, U. S. Row 3: J. de Nekker, The Netherlands; Dr. B. E. Davies, Wales; J. Fowler, U. S.; G. B. M. Oliver, England; Dr. J. H. J. Terwindt, K. d'Angremond, M. A. Viergever, Dr. A. J. de Groot, The Netherlands. Row 4: Y. Monbet, France; C. C. Calhoun, Dr. W. D. Barnard, Dr. C. R. Lee, Dr. R. M. Engler, Dr. B. L. Folsom, U. S.; J. Brakel, The Netherlands.

Boarding launches to dredge

Briefing on dredge by Vicksburg District personnel (Buddy Boren speaking)

Dustpan raised for inspection by participants

Dr. Davies and Mr. Oliver near dredge discharge point

Figure 2. Field day activities

Table 1

LIST OF ATTENDEES

Name	Organization	Name	Organization
Mr. Kees d'Angremond	Adriaan Volker Dredging Co., The Netherlands	Mr. Braxton Kyzer	U. S. Army Engineer District, Charleston, Charleston, SC
Dr. William B. Barnard	Environmental Laboratory, WES, Vicksburg, MS	Mr. Y. Monbet	Centre National Pour L'Exploitation Des Oceans, Brest Cedex, France
Mr. Joost Brakel	Adriaan Volker Dredging Co., The Netherlands	Mr. Ray L. Montgomery	Environmental Laboratory, WES, Vicksburg, MS
Mr. Charles C. Calhoun, Jr.	Environmental Laboratory, WES, Vicksburg, MS	Mr. Michael D. Mullin	U. S. Environmental Protection Agency, Grosse Ille, MI
Dr. Kenneth Y. Chen	University of Southern California, Los Angeles, CA	Mr. Lourens Nederlof Mr. Jaap de Nekker	Municipality of Rotterdam Harbor Department, The Netherlands
Mr. W. W. Curtis	Lower Mississippi Valley Division, Vicksburg, MS	Dr. M. M. Nichols	Virginia Institute of Marine Science, Gloucester Point, VA
Dr. Brian E. Davies	University College of Wales, Dyfed, Wales	Mr. G. B. M. Oliver	National Ports Council, London, England
Dr. Robert M. Engler	Environmental Laboratory, WES, Vicksburg, MS	Mr. Thomas R. Patin	Environmental Laboratory, WES, Vicksburg, MS
Dr. Ulrich Forstner	University of Heidelberg, Federal Republic of Germany	Dr. W. H. Patrick	Louisiana State University, Baton Rouge, LA
Mr. Jack Fowler	Environmental Laboratory, WES, Vicksburg, MS	Dr. Spencer A. Peterson	U. S. Environmental Protection Agency, Corvallis, OR
Dr. Robert Gambrell	Louisiana State University, Baton Rouge, LA	Dr. Russell H. Plumb, Jr.	Great Lakes Laboratory, Buffalo, NY
Dr. Ane Jan de Groot	Institute for Soil Fertility, The Netherlands	Dr. Roger T. Saucier	Environmental Laboratory, WES, Vicksburg, MS
Dr. T. Allan Haliburton	Oklahoma State University, Stillwater, OK	Dr. J. H. J. Terwindt	Geographical Institute, The Netherlands
Mr. Richard W. Holland	Posford, Pavry & Partners, Peterborough, UK	Mr. Marinus A. Viergever	Delft Soil Mechanics Laboratory, The Netherlands
Dr. R. H. Jones	Jones, Edmunds, & Associates, Inc., Gainsville, FL	Dr. J. Wiersma	Rijkswaterstaat, The Netherlands

Table 2

PRESENTATION TOPICS

Topics	Participants	Topics	Participants
Report of Dredged Material Research Program	Dr. Engler Mr. Calhoun Dr. Smith Mr. Patin	Dredged Material Contaminant Geochemical Interactions	Dr. Patrick
Review of 1978 Environmental Dredging Research, Holland	Mr. de Nekker	Contaminant Mobility—Diked Versus Openwater Disposal	Dr. Chen
Regulatory Criteria and Assessment of Methods of Analysis	Dr. Plumb	Chemical Treatment of Dredged Material	Dr. Jones
EPA's Lake Reclamation Program	Dr. Peterson	Pollution Monitoring	Mr. Holland
Environmental Consequences of Unregulated Toxic Waste Disposal in Historic British Lead Mining Districts	Dr. Davies	Metals in Sewage Material	Dr. Forstner
Sediment-Related Research in the Great Lakes	Dr. Mullin	Closure of the Eastern Scheldt Estuary	Mr. d'Angremond
Fluid Mud Associated with Dredged Material Disposal	Dr. Nichols	Heavy Metals in the Dutch Delta	Dr. de Groot
Consolidation of Mud in Relation to Dredging and the Environments	Mr. Nederlof	Current Research in The Netherlands into Sea Disposal of Dredged Material	Dr. Wiersma
Research on Consolidation of Sediments	Mr. Viergever	Dispersion of Dredged Material in the North Sea	Dr. Terwindt
Sizing of Confined Disposal Areas	Mr. Montgomery	Prediction of Dredged Material Dispersion	Dr. Barnard
Dredged Material Dewatering	Dr. Haliburton	Dike Construction Using Engineering Fabrics	Dr. Haliburton
Dredged Material Dewatering with Underdrains	Mr. Fowler	Disposal Problems and Practices in the Charleston District	Mr. Kyzer

NEW DMRP PUBLICATIONS

Virginia Institute of Marine Science, "Habitat Development Field Investigations, Windmill Point Marsh Development Site, James River, Virginia; Appendix D: Environmental Impacts of Marsh Development with Dredged Material: Botany, Soils, Aquatic Biology, and Wildlife," WES Technical Report D-77-23, June 1978, prepared for the Environmental Laboratory. (Work Unit 4A11I.)

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Bingham, C. R., "Aquatic Disposal Field Investigations, Duwamish Waterway Disposal Site, Puget Sound, Washington; Appendix G: Benthic Community Structural Changes Resulting from Dredged Material Disposal, Elliott Bay Disposal Site," WES Technical Report D-77-24, August 1978, Environmental Laboratory. (Work Unit 1A10B.)

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Windom, H. L., "Ability of Salt Marshes to Remove Nutrients and Heavy Metals from Dredged Material Disposal Area Effluents," WES Technical Report D-77-37, December 1977, prepared under contract for the Environmental Laboratory. (Work Unit 6B09.)

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Sweeny, R. A., "Aquatic Disposal Field Investigations, Ashtabula River Disposal Site, Ohio; Appendix A: Planktonic Communities, Benthic Assemblages, and Fishery," WES Technical Report D-77-42, July 1978, prepared by Great Lakes Laboratory for the Environmental Laboratory. (Work Unit 1A08A.)

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Webb, J. W., et al., "Habitat Development Field Investigations, Bolivar Peninsula Marsh and Upland Habitat Development Site, Galveston Bay, Texas; Appendix D: Propagation of Vascular Plants and Postpropagation Monitoring of Botanical Soil, Aquatic Biota, and Wildlife Resources," WES Technical Report D-78-15, June 1978, prepared by Texas Agricultural Experiment Station, Texas A&M University, for the Environmental Laboratory. (Work Unit 4A13F.)

Raster, T. E., et al., "Development of Procedures for Selecting and Designing Reusable Dredged Material Disposal Sites," WES Technical Report D-78-22, June 1978, prepared by Acres American, Incorporated, for the Environmental Laboratory. (Work Unit 5C05.)

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Hoeppel, R. E., et al., "Physical and Chemical Characterization of Dredged Material Influents and Effluents in Confined Land Disposal Areas," WES Technical Report D-78-24, June 1978, Environmental Laboratory. (Work Unit 2D01.)

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Barry, W. J., et al., "Habitat Development Field Investigations, Nott Island Upland Habitat Development Site, Connecticut River, Connecticut; Appendix C: Postpropagation Monitoring of Vegetation and Wildlife," WES Technical Report D-78-25, August 1978, prepared by Connecticut College for the Environmental Laboratory. (Work Unit 4B04F.)

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Cole, R. A., "Habitat Development Field Investigations, Buttermilk Sound Marsh Development Site, Atlantic Intracoastal Waterway, Georgia; Summary Report," WES Technical Report D-78-26, July 1978, Environmental Laboratory. (Work Unit 4A12A.)

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Palermo, M. R., "Needs and Areas of Potential Application of Disposal Area Reuse Management (DARM)," WES Technical Report D-78-27, June 1978, Environmental Laboratory. (Work Unit 5C09.)

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NOTE: Copies of the above reports will be furnished to individual requestors as long as supplies last. Since it is only feasible to print a limited number of copies, requests for single rather than multiple copies by a single office will be appreciated. Please address all requests to the Waterways Experiment Station, ATTN: Ms. D. P. Booth. When supplies are exhausted, copies will be obtainable from the National Technical Information Service, 5205 Port Royal Road, Springfield, VA 22151.

Souder, P. S., et al., "Dredged Material Transport Systems for Inland Disposal and/or Productive Use Concepts," WES Technical Report D-78-28, June 1978, prepared by the General Research Corporation for the Environmental Laboratory. (Work Unit 3B01.)

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Peddicord, R. K., and McFarland, V. A., "Effects of Suspended Dredged Material on Aquatic Animals," WES Technical Report D-78-29, July 1978, prepared by the Bodega Marine Laboratory, University of California, for the Environmental Laboratory. (Work Unit 1D09.)

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Schubel, J. R., et al., "Field Investigations of the Nature, Degree, and Extent of Turbidity Generated by Open-Water Pipeline Disposal Operations," WES Technical Report D-78-30, July 1978, prepared by the Marine Sciences Research Center, State University of New York at Stony Brook, for the Environmental Laboratory. (Work Unit 6C02.)

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Eckert, J. W., et al., "Design Concepts for In-Water Containment Structures for Marsh Habitat Development," WES Technical Report D-78-31, July 1978, prepared by the U. S. Army Coastal Engineering Research Center for the Environmental Laboratory. (Work Unit 4A07A.)

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Kruczynski, W. L., Huffman, R. T., and Vincent, M. K., "Habitat Development Field Investigations, Apalachicola Bay Marsh Development Site, Apalachicola Bay, Florida," WES Technical Report D-78-32, August 1978, prepared by Environmental Systems Service of Tallahassee, Inc., and Environmental Laboratory. (Work Unit 4A19A.)

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Phillips, R. C., et al., "Habitat Development Field Investigations, Port St. Joe Seagrass Demonstration Site, Port St. Joe, Florida; Summary Report," WES Technical Report D-78-33, July 1978, prepared by the Seattle Pacific College and the Environmental Laboratory. (Work Unit 4E03.)

Moherek, A. J., "Flume Experiments on Sand, Silt, and Clay Mixtures from the Offshore Dredged Material Disposal Site, Galveston, Texas," WES Technical Report D-78-34, June 1978, prepared by the Department of Oceanography, Texas A&M University, for the Environmental Laboratory. (Work Unit 1B08A.)

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Maurer, D. L., et al., "Vertical Migration of Benthos in Simulated Dredged Material Overburdens; Volume I: Marine Benthos," WES Technical Report D-78-35, June 1978, prepared by the College of Marine Studies, University of Delaware at Lewes, for the Environmental Laboratory. (Work Unit 1D03.)

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Gupta, S. C., et al., "The Agricultural Value of Dredged Material," WES Technical Report D-78-36, July 1978, by Agricultural Research Service, North Central Region, U. S. Department of Agriculture, for the Environmental Laboratory. (Work Unit 4C03.)

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JBF Scientific Corporation, "An Analysis of the Functional Capabilities and Performance of Silt Curtains," WES Technical Report D-78-39, July 1978, prepared for the Environmental Laboratory. (Work Unit 6C06.)

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Nichols, M. M., et al., "A Field Study of Fluid Mud Dredged Material: Its Physical Nature and Dispersal," WES Technical Report D-78-40, July 1978, prepared by the Virginia Institute of Marine Science and Lafayette College at Easton for the Environmental Laboratory. (Work Unit 6C07.)

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Johnson, B. H., and Holliday, B. W., "Evaluation and Calibration of the Tetra Tech Dredged Material Disposal Models Based on Field Data," WES Technical Report D-78-47, August 1978, prepared by the Hydraulics Laboratory and Environmental Laboratory. (Work Unit 1B06 and 1B07.)

Shuba, P. J., Tatem, H. E., and Carroll, J. H., "Biological Assessment Methods to Predict the Impact of Open-Water Disposal of Dredged Material," WES Technical Report D-78-50, August 1978, Environmental Laboratory. (Work Unit 1E08.)

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Maguire, J. D., and Heuterman, G. A., "Influence of Pregermination Conditions on the Viability of Selected Marsh Plants," WES Technical Report D-78-51, August 1978, prepared by Seed Technology Laboratory, Washington State University, for the Environmental Laboratory. (Work Unit 4A21.)

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Ecosystem Research and Simulation Division, "Design of a Laboratory Microcosm for Evaluating Effects of Dredged Material Disposal on Marsh-Estuarine Ecosystems," WES Technical Report D-78-52, August 1978, Environmental Laboratory. (Work Unit 1D08.)

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Wright, T. D., "Aquatic Dredged Material Disposal Impacts," WES Technical Report DS-78-1, August 1978, Environmental Laboratory. (Task 1A.)

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Holliday, B. W., "Processes Affecting the Fate of Dredged Material," WES Technical Report DS-78-2, August 1978, Environmental Laboratory. (Task 1B.)

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Burks, S. A., and Engler, R. M., "Water Quality Impacts of Aquatic Dredged Material Disposal (Laboratory Investigations)," WES Technical Report DS-78-4, August 1978, Environmental Laboratory. (Task 1C.)

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Hirsch, D. H., DiSalvo, L. H., and Peddicord, R., "Effects of Dredging and Disposal on Aquatic Organisms," WES Technical Report DS-78-5, August 1978, prepared by the Naval Biosciences Laboratory, University of California, Naval Supply Center, Oakland, California, for the Environmental Laboratory. (Task 1D.)

Brannon, J. M., "Evaluation of Dredged Material Pollution Potential," WES Technical Report DS-78-6, August 1978, Environmental Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Task 1E.)

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Haliburton, T. A., "Guidelines for Dewatering/Densifying Confined Dredged Material," WES Technical Report DS-78-11, September 1978, Environmental Laboratory. (Task 5A.)

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Simmers, J. W., "A Survey of Potential Medical and Veterinary Diseases at Habitat Development Field Sites," WES Miscellaneous Paper D-78-1, July 1978, Environmental Laboratory. (Work Unit 2A10.)

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Held, J. W., "Environmental Impact of Dredging Disposal on the Upper Mississippi River at Crosby Slough," WES Miscellaneous Paper D-78-2, August 1978, prepared by River Studies Center, University of Wisconsin, for the Environmental Laboratory. (Work Unit 2A04.)

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Haliburton, T. A., Fowler, J., and Langan, J. P., "Perimeter Dike Raising with Dewatered Fine-Grained Dredged Material at Upper Polecat Bay Disposal Area, Mobile, Alabama," WES Miscellaneous Paper D-78-3, August 1978, prepared by the U. S. Army Engineer District, Mobile, and Environmental Laboratory. (Work Unit 5A20.)

NEW LITERATURE

Bak, R. P. M., "Lethal and Sublethal Effects of Dredging on Reef Corals," *Marine Pollution Bulletin*, Vol 9, No. 1, January 1978, pp 14-16.

Effects of dredging on a coral reef are described. Under water light values at a depth of 12-13 m were reduced from aobut 30% to less than 1% surface illumination. Colonies of coral species which are inefficient sediment rejectors (*Porite astreoides*) lost their zooxanthellae and died. Calcification rates in *Madracis mirabilis* and *Agaricia agaricites* were observed to decrease by 33%. The period of suppressed calcification exceeds that of environmental disturbance.

Boehm, P. D., and Quinn, J. G., "Hydrocarbons in Sediments and Benthic Organisms from a Dredge Spoil Disposal Site in Rhode Island Sound," EPA-600/3-77-092, November 1977. U. S. Environmental Protection Agency, Narragansett, Rhode Island.

The hydrocarbon contents of surface sediments, sediment cores, and ocean quahogs (*Arctica islandica*) from Rhode Island Sound have been determined. Hydrocarbon concentrations in surface sediments normally range from 1.0 to 56.1 $\mu g/g$, largely dependent on sediment type and sedimentation rates. However, concentrations up to 301 $\mu g/g$ are observed in surface samples from a dredge spoil deposit located in the study area. Based on (1) qualitative and quantitative hydrocarbon distributions in the sediments, (2) the hydrocarbon to organic carbon ratio, and (3) the ratio of the concentration of a prominent cycloalkene compound to organic carbon, the normal hydrocarbon geochemistry of the region is defined. Using these criteria, the effect of the dredge spoil deposit (containing 5 to 20 $\times 10^3$ metric tons of hydrocarbons) is seen to be insignificant beyond 2 km from the disposal site.

Hydrocarbon contents of the ocean quahog do not reflect the sediment distributions qualitatively or quantitatively. Throughout the study area the clams' hydrocarbon contents vary by a factor of 2.5 (2.6 to 6.4 $\mu g/g$ wet) while the sediment concentrations vary by two orders of magnitude. The hydrocarbon assemblage in the clams exhibits a lower boiling point distribution than that in the sediments.

Key components of the surface sediments are two cycloalkene compounds of molecular weight 344 and 348. Their concentration covaries very significantly with the organic carbon content of the sediment. A major component of *Arctica* is another related cycloalkene of molecular weight 342. This compound is not present in the sediment.

A sediment core from the area shows a decreasing concentration of hydrocarbons and a decreasing percentage of unresolved components (UCM) with increasing depth. It is proposed that the rapid increase in the quantity of the UCM observed at a certain depth within the sediment can serve as a chemical marker in the recent sedimentary record. This marker corresponds to the onset of the industrial revolution and the increased usage of petroleum products.

This report was submitted in fulfillment of Grant Number R803415 under the sponsorship of the Environmental Protection Agency. The work cited in this report was completed as of January 1977 and is included in the Ph. D. thesis of Paul D. Boehm (University of Rhode Island, 1977). This work has also been submitted (March 1977) for publication to the Journal, Estuarine and Coastal Marine Science in a paper entitled, "Benthic Hydrocarbons of Rhode Island Sound," by Paul D. Boehm and James G. Quinn.

Cheam, V., et al., "Examination of the Elutriate Test, A Screening Procedure for Dredging Regulatory Criteria," *Journal of Great Lakes Research*, Vol 2, No. 2, December 1976, pp 272-282.

Water quality parameters were considered in a series of tests, including the Standard Elutriate Test designed to appraise the elutriate techniques. Both the conditional stability constant and the complexing capacity of the elutriate were greater than those of background waters. Although the concentration of the Standard Elutriate can be greater than 1.5 times the original concentration for the four heavy metals considered (Zn, Hg, Pb, Cd), it may be still less than the standards for drinking water and freshwater or marine aquatic life. Thus, such releases themselves should not significantly affect the water quality. It appears that improvement of the existing dredging regulatory criteria concerning Hg, Pb, and Zn is desirable. On the other hand, tests indicated that the release of phosphorus can be large and might significantly affect the water quality in actual open water disposal. It was suggested, therefore, that further research be performed to elucidate the behavior of phosphorus release from dredged spoils, and that the concentrations of phosphorus and other constituents in the elutriates be compared to the standards. Finally, it was suggested that an acceptable test should realistically reflect the occurrence at the disposal site and, consequently, should at least incorporate an estimated resulting sediment-water ratio and a mixing process representative of the dump site.

FitzPatrick, J. A., Atmatzidis, D., and Krizek, R. J., "Physical and Conceptual Simulation of Effluents from Dredged Material Confinement Facilities," *Water Resources Bulletin*, Vol 13, No. 6, December 1977, pp 1107-1118.

Environmental protection dictates that effluents of desired quality should be discharged from dredged material confinement facilities. In general, this can be accomplished by supplementing the solid-liquid separation obtained by simple sedimentation with appropriate filter systems which provide additional clarification. A methodology to estimate the sedimentation required in a disposal area was developed on the basis of classical sedimentation theories and compared favorably with field data. A procedure then was advanced and documented whereby effluents from dredged material confinement facilities can be modeled successfully for laboratory filtration tests. For these purposes, inorganic suspended solids can be simulated

reasonably well by adjusting the concentration of commercially available clays, and fresh or saline water environments can be simulated satisfactorily by tap water or sodium chloride solutions, respectively.

Go, T. L., Vasuki, N. C., and Canzano, P. S., "Utilization of Wastewater Residues to Reclaim Dredged Embankments," *Water and Sewage Works*, Vol 124, No. 11, November 1977, pp 83-84.

Problems associated with the disposal of municipal wastewater sludge containing higher than normal heavy metal concentrations have resulted in a study by the City of Wilmington, Delaware, on the utilization of wastewater residues for the reclamation of dredged embankments. The federally owned land along the banks of the Chesapeake and Delaware Canal was selected as the sludge disposal test site. Advantages afforded by the site included: protection of the water table aquifer by the mound of dredged materials, little potential for harvesting of food crops, and the need for stabilization of the dredge spoils. Studies were conducted to compare dredge spoil reclamation with digested sludge and commercial fertilizer. Digested sludge from the Wilmington sewage treatment plant was applied to the 16-acre test site at a rate of 45 tons per acre. The area was then seeded with a K-31 tall fescue. Soil core samples taken before and after sludge application were analyzed for metal and anions. The pH of the soil water extract was also measured. Experiences with the sludge application were favorable, as the low pH of the dredge spoil was raised from 3 to 4. The growth and regrowth responses of grasses in the sludge-treated area were also improved. Sludge application reduced the leaching of havy metals from the dredge spoils.

This bulletin is published in accordance with AR 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Dredged Material Research Program (DMRP) could be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Although the DMRP was completed in March 1978, all research results have not yet been disseminated to this wide audience. Hence it is being continued until such time as all significant DMRP results and data are summarized. It will be issued on an irregular basis as dictated by the quantity and importance of information available and compiled for publication. Contributions of notes, news, reviews, or any other type of information are solicited from all sources and will be considered for publication as long as they are relevant to the theme of providing definitive information on the environmental impact of dredging and dredged material disposal operations and the development of technically satisfactory, environmentally compatible, and economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable resource. Special emphasis is placed on materials relating to the application of research results or technology to specific project needs. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: R. T. Saucier, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180, or call AC 601, 636-3111, Ext. 3233 (FTS 542-3233).

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